DOCUMENT RESUME

ED 313 844 EC 221 710

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TITLE Spontaneous Comparative Behavior and Categorization: The Links between Mediated Interaction and Reading Comprehension.
PUB DATE Jul 89
NOTE 25p.; In: Martin, David S., Ed. International Symposium on Cognition, Education, and Deafness (2nd, Washington, DC, July 5-8, 1989). Working Papers: Volume II.
PUB TYPE Speeches/Conference Papers (150) -- Reports - Research/Technical (143)

EDRS PRICE MF01/PC01 Plus Postage.
DESCRIPTORS *Classification; *Cognitive Development; Cognitive Processes; *Deafness; Intermediate Grades; Junior High Schools; *Mediation Theory; *Reading Comprehension; Responses; Teaching Methods; Transfer of Training
IDENTIFIERS *Instrumental Enrichment

ABSTRACT

The study with three profoundly deaf subjects (ages 11-13) investigated whether there is a chain of functional relationships among a method of interaction referred to as a mediation, a cognitive function referred to as spontaneous comparative behavior, the operation of categorization, and the reading comprehension tasks of using lexical cohesion and finding the main idea. Experimental treatment was a mediated experience in teaching the operation of categorization using the categorization instrument from the Feuerstein Instrumental Enrichment Program. The dependent variables of the number of spontaneous comparative responses, the score of the spontaneous comparison, the quality of the commonality, the difference in the response, and the number of most salient verbs and class nouns used were charted for each subject from baseline through treatment. Results indicated a treatment effect for all three subjects for all the dependent variables as well as the acquisition of the operation of categorization. Tests of near- and far-transfer showed inconsistent results. Results suggested a positive level of cognitive modifiability with this population using mediated interaction. (Author/DB)

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SPONTANEOUS COMPARATIVE BEHAVIOR AND CATEGORIZATION: THE LINKS BETWEEN MEDIATED INTERACTION AND READING COMPREHENSION

Janice Berchin, Ed.D.

Abstract

The reading achievement level for deaf individuals is far below the achievement levels of hearing students of comparable age (Furth, 1966; Gentile & DiFrancesca, 1969; Lane & Baker, 1974). The average reading level of deaf adults when leaving school is approximately fourth grade on standard reading achievement tests (King & Quigley, 1985). This is about the same level as a typical nine or ten-year-old hearing student.

The ability to comprehend when reading involves numerous cognitive, linguistic, and experiential processes and manifests itself in the ability to perform various activities. The great difficulty for deaf individuals when coming to the reading task lies in deficits or problems in those requisite cognitive processes, as well as in real world knowledge and linguistic skills (King & Quigley, 1985). Feuerstein (1979) has developed a theoretical construct which explains the etiology of cognitive deficiencies among retarded performers. This construct, called mediated learning experience (MLE), can also be applied to the deaf population (Keane, 1983). This study investigated whether there is a chain of functional relationships among a method of interaction referred to as mediation, a cognitive function referred to as spontaneous comparative behavior, the operation of categorization, and the reading comprehension tasks of using lexical cohesion and finding the main idea. The treatment was the Categorization "instrument" from the Feuerstein Instrumental Enrichment Program (Feuerstein, 1979).

The overall procedure for this study followed a multiple baseline across-subjects design. Baseline was a traditional or direct experience in teaching the operation of categorization while the experimental treatment was a mediated experience in teaching the operation of categorization. The dependent variables of the number of spontaneous comparative responses, the score of the spontaneous comparison, the quality of the commonality and the difference in the response, and the number of most salient verbs and class nouns used were charted for each subject from baseline through treatment. The dependent variables were also charted to investigate the acquisition of the operation of categorization. The subjects were probed four times through the study for the near transfer of the ability to compare spontaneously and categorize and the far transfer of the reading comprehension tasks of using lexical cohesion and choosing the main idea.

Results indicated a treatment effect for all three subjects for all the dependent variables as well as for the acquisition of the operation of categorization. In addition, a treatment effect was established for the near transfer of spontaneous comparison. However, a treatment effect was only evident for two subjects for one test of the near transfer of categorization and one subject for the other near-transfer test of categorization. The far-transfer results were inconsistent. Although there was an upward trend for all three subjects on all tests, a treatment effect was only established for one of the far-transfer tests.

EC 221710

Introduction

Through history, the attainment of successful reading for deaf persons has frustrated educators of the deaf. The discrepancy between reading achievement levels for hearing-impaired and hearing individuals is well-documented in the literature (Furth, 1966; Gentile & DiFrancesca, 1969; Lane & Baker, 1974). Studies documenting the achievement levels of hearing-impaired students over the last ten years by the Center for Assessment and Demographic Studies at Gallaudet University indicate that only ten per cent of this nation's hearing-impaired children reach eighth grade reading level by age 14--the reading level achieved by the average hearing child of the same age (Trybus & Karchmer, 1977: Allen, 1986). The average reading level of deaf adults upon leaving school is approximately at the fourth grade. In addition, the population of congenitally deaf individuals tends to reach a plateau level with regard to reading comprehension at age 13 or 14, with very little change through adulthood (DiFrancesca, 1972).

Reading Comprehension

Most research has examined the linguistic abilities of deaf individuals so as to explain the difficulty they have comprehending when reading (Quigley et al., 1977; Hatcher & Robbins, 1978, 1981). However, an examination of the cognitive abilities for the requisites for reading comprehension is essential. Reading researchers have utilized schema theory (Rumbelhart, 1980), to help gain insight into how people read. This theory appears to focus on schemata formation and use, semantic memory, and the cognitive function of spontaneous comparison, and the operation of categorization as essential cognitive components of the reading process. Comprehension in this orientation involves correctly assessing a cross-indexed conceptual filing

system. Each concept has a "file" (schema) in our minds, and we add to that file by relating more and more information into it. However, it is not enough to have individual concepts; it is also necessary that these concepts relate to one another. When processing incoming information, the incoming information is related to what is already established in our cognitive framework. It is these formed interrelationships that allow individuals to use their existing knowledge base to expand, incorporate, or complement incoming information, thus giving the greatest opportunity for comprehension. This cognitive approach delineates two major functions of the comprehension system: the information of concepts and the interrelations among these concepts.

The representation of schemata has been graphically represented in a variety of "networks." One such network is called a "semantic network" (Collins & Quillian, 1969; Collins & Loftus, 1974; Lintsch, 1977); it consists of nodes and links between nodes. Nodes represent concepts (words), and links represent relations between concepts. Nodes and their links are integral to understanding printed text. Investigations have shown the importance of the availability of a well-developed schema for a topic to understand reading selections on that topic (Anderson, Spiro, & Anderson, 1978; Pearson, Hensen, & Gordon, 1978), as well as the abilities to select and maintain schema during reading. In this orientation, comprehension results when new information enters our cognitive field and interacts with the existing schemata.

One manifestation of node linkage in printed text is the existence of cohesion between the sentences within the text. English has a variety of mechanisms to tie sentences together. One such mechanism is lexical cohesion (Halliday & Hasen, 1976). Two types of lexical cohesion are reiteration and collocation. Reiteration is the repetition of a lexical item, use of a synonym or near synonym, or a subordinate term or general word to refer to a lexical item.

Collocation is cohesion that is achieved through the association of items that regularly co-occur,

such as antonyms, order series, and recognizable semantic relations to one another. In order to benefit from lexical cohesion, whether it be reiteration or collocation, a reader must semantically process the given lexical items and tie one lexical item to the other lexical environments.

Collins and Quillian (1970) present a spreading activation account of human semantic processing which can be applied when people process words, sentences, and prose (Collins & Loftus, 1975). In this account, when a concept node is activated, other nearby concept nodes are also activated. Activation spreads outward from the original node such that nodes that are close in semantic distance to the processed concept within a given context receive more activation that those nodes that are further removed from the original concept. This activation processing sets up the possible conditions that facilitate reading comprehension with respect to lexical cohesion since one node facilitates processing of the next node (Shoben, 1980).k

It appears, then, that the successful use of lexical cohesion involves two major abilities, one being semantic processing (being able to make or having appropriate node linkages), and the other being word knowledge. Word knowledge has always been identified as a significant component of comprehension (Pressy & Pressy, 1921; Hillard, 1924; Albright, 1927; Davis, 1944). In the cognitive model of word knowledge referred to as the knowledge hypothesis, word knowledge is viewed within the context of what a person knows. Not only are individual word meanings important, but the entire linked conceptual framework elicited by word meanings is thought to interact with text to result in comprehension for the reader.

This group of linked associations can be thought of as a category in that a category exists whenever two or more distinguishable objects or events are treated equivalently (Mervis, 1980). Equivalent treatment can exist in the forms of labeling distinct objects or events with the same name or performing the same action on different objects. If this definition of a category is applied to the group of associative links as described by the knowledge hypothesis, it appears that a schema can be viewed as a category.

Thus, if readers do categorize information, then teaching and learning new vocabulary should be facilitated by using strategies capitalizing on this feature. Researchers have not considered the teaching of the operation of categorical thinking in order to organize information into nodes and links which would then activate semantic processing and facilitate active lexical cohesion while comprehending text.

In addition to lexical cohesion at the word level across sentences which serve to connect propositions, connections between propositions are also necessary for comprehension of larger units of text while reading. This phenomena can be exhibited through the ability to select the main idea. The main idea and supporting details constitute basically a logical relationship between general and more specific proposition. In this regard, finding or inducting the main idea, topic, or a topic sentence is similar to finding a category label for a list of words (Pearson & Johnson, 1978). Therefore, it is suggested that teaching the cognitive operation of categorization may enhance reading comprehension both on the word and propositional levels.

Deaf Learners and Cognitive Requisites for Reading

To date there has been almost no research directly on schema development with deaf students. From a study by Gaines et al. (1981) and a study by Kluwin et al (1980), it can be concluded that deaf individuals do bring their world knowledge to bear on the reading task.

However, a study by Strassman (1985) indicated that deaf subjects did not make use of their knowledge by spontaneously instantiating.

Investigation into semantic processing (memory) while reading in hearing-impaired individuals has involved the associate meanings of words. Research has shown that deaf persons have restricted semantic fields (Restino, 1969), have difficulty in defining words (Silverman & Rosenstein, 1969), and define words based on associations rather than critical features (Silverman & Rosenstein, 1969). McGettigan and Rosenstein (1969) demonstrated that not only did deaf children confuse their word meanings with word associations, but also that the strength of the associative relationship had no bearing on their choice of meanings. Recently, other researchers have shown that deaf readers use associational relationships as a strategy for answering questions on reading tests (Webster et al., 1981; Wolk & Schildroth, 1984; Wood et al., 1981). This finding is not only consistent with the work of McGettigan and Rosenstein (1969) and Silverman and Rosenstein (1969), but expands Silverman and Rosenstein's findings. As a body, the research demonstrates that deaf individuals not only have vague word definitions, but also use a global approach to comprehension of sentences rather than a clear view of the context. These results, viewed in terms of schema framework, suggest that deaf individuals do not have sharply defined conceptual meanings of nodes in a particular schema and that the links necessary to complete a full schema are either weak, inadequate, or non-existent (Strassman, Kretschmer, & Bilsky, 1987). Another study (Berchin & Kretschmer, in preparation) also supports these findings; deaf adults reading at about fourth grade level were found typically not to utilize lexical cohesion when processing given sentence pairs in order to help make the connection between the two sentences and treat them as a unit. This finding may reflect a weakness in semantic processing and/or in forming defined categorical schemata.

Taken together, these results suggest that deaf persons are limited in the categorical organization of information presented via English print which may impact upon understanding or gaining information from printed text.

Other research (Hoemann, Andrews, & DeRosa, 1974; Tweeney, Hoemann, & Andrews, 1975; Liben, 1979) has demonstrated that while hearing-impaired children are similar to their hearing peers in their ability to use semantic clustering to group words, their ability to recall categorizable items is significantly lower than that of their hearing peers. Liben (1979) suggested that although semantic memory and conceptual knowledge may be organized and used by the deaf in a fashion similar to their hearing peers, the differences between the two groups may reflect that the deaf have inadequate knowledge of category membership or inflexibility in reclassifying items.

A vast number of studies concerning the deaf population and cognitive functions and operations has been conducted during the last 30 years. Reviews of these studies have revealed inconsistent results (Rosenstein, 1961; Furth, 1964, 1971). Most of this research has involved the study of non-verbal cognitive development in deaf persons in an attempt to isolate cognition from language influences. Although this research covers a variety of important areas, some studies provide more insight into the reading process inasmuch as they can be viewed in terms of the cognitive requisites for successful reading. Among these is the ability of deaf children to categorize.

There have been a number of studies conducted to investigate the association, sorting, and classification abilities of deaf individuals. It has been shown through this research that deaf people performed equally as well as hearing people when associating objects to color and letters to geometric figures (Furth, 1964; Furth & Youniss, 1964); performed worse than hearing

controls when asked to transfer the associating process (Furth et al., 1965); performed significantly lower than hearing subjects when responding to two pieces of information (Furth, 1964); performed worse that hearing subjects on a task involving the ability to classify objects according to similarity in form and dimension, form and color, and color and dimension (Vincent, 1957); and performed worse than their hearing peers when asked to select pictures that belong together (Furth & Milgram, 1965).

Ottem (1980) analyzed the cognitive studies and suggested a classification system of tasks and problems used in studies with deaf people. This system was based on certain routines or steps necessary for the subject to follow to show his or her understanding of the solution of non-verbal problems. These steps were identified by determining the least amount of data needed by a person outside the experimental environment to decide whether a subject has shown his or her understanding of the solution of a problem. This classification demonstrated that the deaf and hearing perform equally well when required to show their understanding by referring to one of two such minimum data. However, the deaf perform worse than their hearing peers when required to refer to both of two such data. Ottem (1980) suggested that the difficulty deaf people have referring to both pieces of data stemmed from being trained to communicate in single events. This training results in the cognitive deficiency mentioned by Feuerstein (1979), i.e., an inability to hold and use two sources of information. This function would be extremely important to have intact since a successful reader needs to held and integrate multiple pieces of information as he or she reads a text (Anderson, 1981). This function is also crucial for categorization, as it is necessary to hold two sources of information in order to compare, thus enabling categorization to take place (Feuerstein, 1980).

Mediational Intervention

Feuerstein (1980) has developed a theoretical construct which explains the etiology of cognitive deficiencies among retarded performers. Feuerstein asserts that this construct, called "mediated learning experience," is necessary for the development of organized, efficient cognitive structures. This "experience" involves the active interaction on the part of an intentioned and caring adult who interposes himself or herself between the world of objects and events and the child, and by doing so "mediates" the stimuli in such a way that each stimulus is changed as it reaches the organism. Research has shown the mediated experience to be very applicable to the assessment of deaf individuals (Keane, 1983; Keane & Kretschmer, 1987; Katz, 1984; Krapf, 1985). In addition, Martin and Jonas (1986) found the curriculum Instrumental Enrichment, based on Feuerstein's theory, to be very effective for the deaf adolescent in the analysis of problem situations, finding sources of error, completeness, organization and planning in problem-solving situations, and abstract thinking. This construct had not, however, been applied to specific academic content in the classroom. Broadly, the purpose of the study to be discussed was to investigate that particular application, i.e., the cognitive modifiability of a specific cognitive function and the transfer of the modified function to a specific academic content. More specifically, this study attempted to determine whether a chain of functional relationships exists between a particular method of interaction referred to as mediated learning, a cognitive function referred to as spontaneous comparative behavior, the operation of categorization, and the reading comprehension tasks of using lexical cohesion and finding the main idea.

Within the study the mediated interaction was germane to the treatment and was process-oriented. The instructor controlled how the student gathered, utilized, and explained information. This activity involved asking the student to reflect on the activity, helping the

student understand how the activity related to other activities, discussing the importance of the activity, and facilitating the student's ability to apply underlying principles and procedures within and outside the task at hand. The instructor used probing questions to facilitate problem-solving and process-oriented thinking. The main intent of this interaction was to effect cognitive structures (thinking processes) and for the student to learn a repertoire of thinking strategies while completing the task, which might include making a plan for attacking the task at hand, justifying responses, summarizing the task, and comparing the task to other tasks.

This type of interaction is in contrast to conventional teaching. Teaching is sometimes considered to be a direct experience in which the main intent is to give new information to the learner. This study is based on the underlying assumption that deaf students have been taught categorization through direct experience. Therefore, the type of interaction is the question--that is, will a mediated interaction facilitate learning? More specifically, can mediation be an effective vehicle to develop the requisite operation of categorization for reading comprehension tasks?

Study of Mediation Intervention:

Effect and Transfer to Reading Comprehension

The overall research design for this study was a single-subject multiple-baseline across subjects. A single-subject design was chosen because of the necessary length of treatment time with each subject. The Categorization Instrument from the Feuerstein Instrumental Enrichment Program (FIE) (Feuerstein, 1980) as a mediational interaction treatment was applied in sequence across three profoundly deaf subjects exposed to the identical classroom environment. Thus, as the same treatment variable was applied to succeeding subjects, the baseline for each subsequent subject increased in length. One formal test (Stanford Reading Achievement Test)

and three informal tests (Language Sample, Spontaneous Comparison Cards, and Categorization Cards) were used for the subject selection process to ensure that the three subjects met a minimum set of criteria. Three additional instruments and two tests used in subject screening (the Spontaneous Comparison Cards and the Categorization Cards) served as the probe battery. The Spontaneous Comparison Cards were designed to address the first and foremost subgoal of FIE, i.e., the correction of deficient functions as a means to changing the structure of the cognitive behavior of the retarded performer. The data from the Spontaneous Comparison Cards involving the commonality and the most salient aspect addressed the second subgoal of FIE, i.e., the acquisition of basic concepts, labels, vocabulary, operations, and relationships. The set of Categorization Cards and the Test of Verbal Abstraction from the Learning Potential Assessment Device (Feuerstein, 1979) examined the near transfer of the acquisition of the concepts, labels, vocabulary, operations, and relationships. The fourth and fifth tests were measures of reading comprehension tasks: one involving the use of lexical cohesion and the other choosing the main idea. These tests were designed to address the major goal of FIE, i.e., to increase the capacity of the individual to become modified through direct exposure to stimuli, allowing generalization and transfer of learned information to novel situations.

Baseline instruction represented a direct-experience approach to teaching categorization and used a Classification Workbook (Curriculum Associates Curricula, 1981). Instruction continued until a stable baseline was established. Once a stable baseline was established, Subject ONe began the treatment phase. Specifically, this treatment consisted of mediated instruction on the Categorization Instrument from the Feuerstein Instrumental Enrichment Program. When Subject One obtained six scores indicating an upward trend on the spontaneous comparison cards during treatment phase, Subject Two began treatment. The same

criterion was used to begin Subject Three in treatment. Each time a new subject began treatment, the battery of probe tests was given to all three subjects. The purpose of the probe battery was not only to examined the effect of a mediated learning experience on the acquisition of the ability to categorize and the remediation of the cognitive function of spontaneous comparative behavior, but also to examine the transfer of that enhanced functioning to two reading tasks (lexical cohesion and main idea). It is important to note that treatment did not involve instruction in the reading tasks. The study investigated whether enhanced cognitive functioning would exhibit enhanced functioning in related reading tasks.

Prior to the beginning of the study, validity testing for the materials and a reliability test for differentiation of interaction type were conducted. Results of this procedure indicated that within ten randomly assorted videotaped segments, three naive raters could differentiate interaction 100% of the time. This reliability procedure was continued throughout the study with the same results. Reliability testing was also conducted throughout the study for scoring of the dependent variables, resulting in 90% agreement between one rater and the examiner and 94% with the other rater.

Three profoundly prelingually deaf youngsters between the ages of 11 and 13 served as subjects for this study. All subjects were enrolled in a school for the deaf and were reading at a grade level between 2.0 and 2.5 on standardized reading tests. In addition, the subjects had been unable to compare spontaneously or use the operation of categorization in screen testing.

The actual session consisted of either baseline or treatment instruction for 40 minutes and the spontaneous comparison cards activity for the final five minutes. The dependent variables were measured from the responses to the sets of spontaneous comparison cards. They were: the number of spontaneous comparative responses; a score of spontaneous comparison

involving the notion of connectivity; the quality of the commonality and difference in the subjects' responses; and the number of most salient verbs and class nouns used by the subjects. Twelve separate sets of Spontaneous Comparison Cards were used to measure the dependent variables. The twelve sets of six cards used throughout the study were drawn by a graphic artist. Within the set of six cards, three cards asked for a class noun or superordinate term as the commonality and for exemplars of that larger noun category as the difference, while three cards asked for a verb as the commonality and for an answer to a who, what, or where question as the difference.

The probe battery consisted of:

1.Spontaneous Comparison Cards. These cards were made from two pages of the Comparison Instrument from the Feuerstein Instrumental Enrichment Program (Feuerstein, 1980). Each card consisted of the cut-out black and white drawing from the Comparison Instrument (Feuerstein, 1980) pasted on a five-by-eight index card. These materials were chosen because, as demonstrated through pilot testing with both hearing adults and successful deaf readers, they successfully provoke a series of spontaneous comparisons (Feuerstein, 1975). That is, the subjects were able to generate a number of responses indicating both similarities and differences between the depicted items. Half of these cards depicted item pairs that were similar on the basis of a class noun, e.g., hats, and the other half on the basis of a verb, e.g., mixing.

2.Categorization Cards. These were ten sets of five cards with a single item drawn on each card. One card was a stimulus card and the other four cards could be categorized with the stimulus card. The responses for the four cards can be either perceptual, functional, or nominal. An intrinsic perceptual response was identified when the items shared a given

attribute or aspect (color, shape, etc.) and an extrinsic perceptual response was identified when the items occupied a position in time or space (e.g., they both belong in a house). An intrinsic functional response was identified when the items shared a similar purpose, and an extrinsic functional response was identified when the items were grouped by what one does with them. Finally, a nominal response was identified when a class name was given for the items.

3.The Test of Verbal Abstraction. This test was one of two used to probe the near transfer of the ability to categorize (the other test was the Categorization Cards). This test was quite similar to those used in standard normative intelligence tests such as the Wechsler Scales and the Stanford-Binet. The test consisted of 20 items. An item consisted of five exemplars of objects or events that had essential common properties and that could be grouped according to a verbal abstraction. Items were administered in the same manner as the similarities subtests of standard normative tests, i.e., a subject was asked in what way the five objects, ideas, or events were alike.

4.Lexical Cohesion Test. This test was used as one of two far-transfer tests. This test was created by the author and was a lexical cohesion task in that the subject was asked to choose the two sentences, each from a list of three, that belonged with two given sentences. More precisely, the subject was to read the two given sentences and then select the sentence that best belonged with those given sentences from List A and then select the sentence that best belonged with the given sentences form List B. It was presumed that the subject would choose the sentences containing the most lexically tied word (the closest activated node belonging in that superordinate category). Choosing the sentences with the most lexically tied words demonstrated a well-defined schema for that particular concept. Activating that schema was hypothesized in turn to facilitate better comprehension for those sentences. For example,

given the sentence, "The girl liked all the seasons," activation presumably spread from "seasons" to all the possible seasons along with other notions. Given the second sentence, "Summer is her favorite," "summer" would already be activated so it would be easy to connect to the first sentence. "Summer," in turn, would activate a variety of other concepts including summer-type activities, which would therefore facilitate the subject's choice of the test sentence which contained the closest activated relation. If the test sentence choices in the first group of choices contained: 1) riding in a car, 2) going swimming, or 3) being outside, the closest relation would be swimming. Although all three concepts could be activated by "season" and "summer," "swimming" has the strongest tie since all other choices are general to any time of the year. Therefore, "swimming" should most easily be understood as belonging to the activated schema. The major difference between this far-transfer task and the near-transfer tasks (the Categorization Cards and the Test of Verbal Abstraction) was the difference in the levels of complexity and abstraction.

5.Main Idea Test. The second far-transfer test was a test assessing the ability to choose the main idea of a text, a common reading comprehension task in schools as well as in standardized achievement testing. This test was assembled from two commercial workbooks--Main Idea & Details and Building Basic Reading Skills--designed to teach finding the main idea (The Continental Press, Inc., 1982). The test consisted of 20 items of which ten were on a first grade reading level and ten were on a second grade reading level. The test asked the individual to choose a sentence response. Main idea was the most general idea in a paragraph, a theme that logically subsumed all the other sentences in the paragraph or paragraphs in a passage. Main idea could also be thought of as a topic or category label that generally described what the paragraph was about (Pearson & Johnson, 1978). In this regard, finding the

main idea was operationally the same as finding a category label for a list of words. Finding the main idea required the reader to recognize that some of the propositions were examples of the most general proposition intended to serve as the main idea.

Results indicated a significant treatment effect for all three subjects for all the dependent variables as well as for the acquisition of the operation of categorization. In addition, a treatment effect was established for the near transfer of spontaneous comparison. However, a treatment effect was only evident for two subjects for one test of the near transfer of categorization and one subject for the other near-transfer test of categorization. The far-transfer results were inconsistent. Although there was an upward trend for all three subjects on all tests, a treatment effect was only established for one subject for one of the far-transfer tests.

Discussion and Conclusion

The combined results of the dependent variables and the Spontaneous Comparison Cards from the probe data supports the contention that at least one cognitive function--categorization--in deaf individuals can be significantly enhanced through a mediational approach to interaction. This finding is consistent with other research studies (Keane, 1983; Krapf, 1985; Martin & Jonas, 1986), which suggest a wider applicability of this notion and the potential of long-term effects. In turn, these findings support the applicability of Feuerstein's (1979) theoretical construct of mediated learning to a hearing-impaired population.

Application of mediated learning theory to a deaf population offers a new perspective on the various viewpoints concerning the lack of knowledge due to experiential deficits in this population of individuals. Such diverse positions as the developmental explanation based on Piaget's stages (Liben, 1978), the experiential deficit hypothesis of Levine (1960), the normalcy hypothesis of Furth (1966), and the lack of fluent language and communication system of

Quigley and Paul (1984) can be reconciled when considered from the viewpoint of mediated learning theory. Feuerstein (1979) offers a theoretical construct that appears to explain in more specific terms the experiential deficit that promotes the low functioning manifested by the deaf population, while at the same time suggesting that this functional level is not indicative of the cognitive potential of this population. Such potential is evident within this study: the three subjects demonstrate cognitive modifiability to the extent that increased spontaneous comparative behavior could be realized as a result of appropriate mediation.

A closer look at the transfer tasks provides more insight into the effect of mediation. It may be that the directions for the transfer tests for categorization (the Categorization Cards) affected the results. It is possible that the directions of "tell what is the same" for the transfer categorization task may have manipulated the input just enough for the subject who did not who a treatment effect, to increase the elaboration of categorization and the improved input of category names from the initial probe and throughout the study. This result is in contrast to the directions in the dependent variable cards in which the instructions were to "tell about the cards." This difference in directions represents the difference between spontaneous categorization with slight control of the input phase of the mental act. The former is more general while the latter specifically addresses one aspect of comparative behavior, i.e., commonality. This point may suggest that manipulation of the input can have a powerful effect on the output. This finding is consistent with a study by Huberty and Koller (1984) which found that even minimum input control had a profound effect on the ability of hearing and deaf students to solve a cognitive task. The researchers concluded that "the deaf may have more difficulty with initial input of information than do hearing persons" (Huberty & Koller, 1984, p. 26) but that with minimal input control, significant increases in performance could be

effected. In this view, then, input manipulation can be viewed as a form of mediation. Therefore, it can be concluded that all three subjects had a treatment effect. The two subjects that demonstrated a treatment effect were able to benefit from the input manipulation after they received other mediation. The third subject benefited from the input manipulation which acted as a form of mediation from the outset. This conclusion also would be consistent with the findings of Strassman, Kretschmer, and Bilsky (1987) who found that in contrast to hearing subjects, deaf subjects in their study did not spontaneously instantiate in a reading task, but could when directed to do so (a manipulation of the input).

This discussion of the manipulation of the input may also have merit in terms of the results for the Test of Verbal Abstraction. The results for this near-transfer test were also variable because a treatment effect could be established with only one subject. For the other two subjects the scores steadily increased from Probe 1 to Prove IV. For these two subjects it may be that the difference in the directions manipulated the input just enough to mediate the task and make the difference in performance on this particular test.

The limitation of this study becomes evident in the results of the far-transfer tasks. An underlying assumption in this study was that enhanced functioning in spontaneous comparative behavior and the operation of categorization would indicate better defined schemata within the individual. The far-transfer tests, however, were not able to examine whether better defined schema were actually constructed or whether they were constructed but not activated. This area is an avenue that future research should examine more closely. In addition, research should also be directed toward other cognitive functions and the effect of remediation on related specific academic content.

This study is offered as an initial investigation of the cognitive modifiability of a specific cognitive function and the transfer of that function to specific academic content. The results for this population indicate a positive level of cognitive modifiability with the use of the mediated interaction for the cognitive function of spontaneous comparison. In the classroom, academic learning might be enhanced by using this interaction to remediate the cognitive deficiencies necessary for academic learning.

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